Fermilab Participation in LHC Commissioning/Ops

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FRA Visiting Committee Review

Energy Frontier Session

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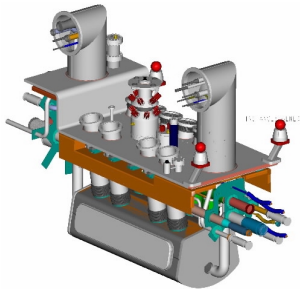
Fermilab

Outline

- DOE's US LHC Accelerator Project
- LHC Accelerator Research Program (LARP)
  - Fermilab roles in LARP
  - Commissioning of LHC Hardware
- Toward Beam Commissioning
  - via LHC Accelerator Research Program (LARP)
  - via LHC@FNAL Software initiative (LAFS)
  - other initiatives
- Summary

US LHC Accelerator Project

- Major US contributions to the LHC accelerator system included:
  - separation dipoles for use around RF section
  - absorbers for use in interaction regions



  - cryogenic feed boxes for IR
  - interaction region quadrupole magnets
- Components completed and delivered to CERN on schedule, on budget

LHC Accelerator Research Program (LARP)

- "LARP" was formed in 2003; DOE "program"
- Jim Strait:

US LHC Accelerator Research Program

The US Hadron Accelerator Community and CERN plan to continue the collaboration established for the construction of LHC.

The goals of this program are to

- Extend and improve the performance of the LHC, so as to maximize its scientific output, in support of US-CMS and US-ATLAS.
- Maintain and develop *the US labs' capabilities*, so that the *US can be the leader* in the next generation of hadron colliders.
- Serve as a vehicle for US accelerator specialists *to pursue their research.*
- *Train future generations* of accelerator physicists.
- It is the next step in *international cooperation* on large accelerators.

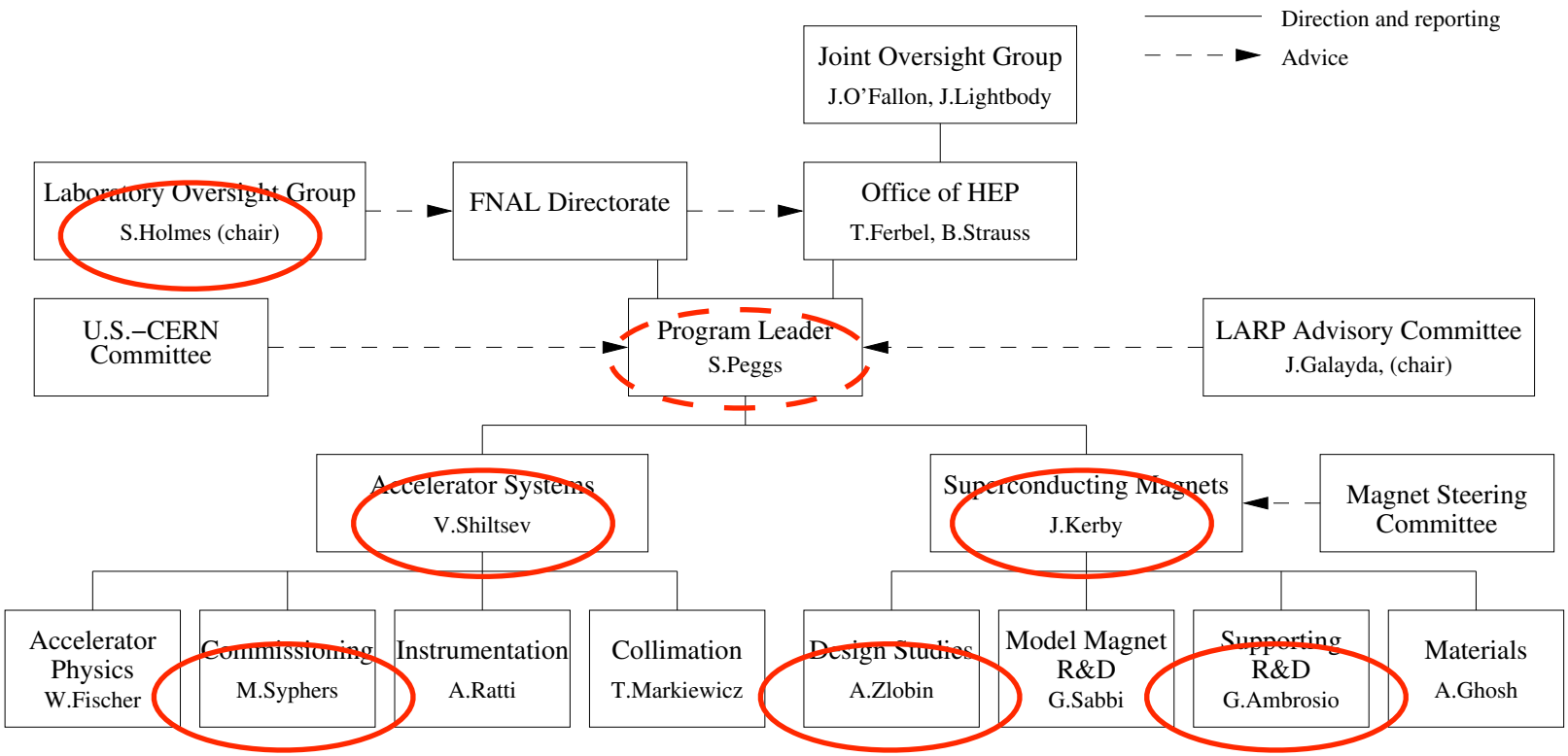
Fermilab has been appointed the "Host Laboratory" to lead this program.

CERN management strongly supports our continued collaboration.

LARP Activities

- Accelerator physics experiments and calculations
  - performance limitations of current IR's; new designs
  - participate in sector tests, machine start-up
  - beam dynamics calculations and experiments
- Developing high-performance magnets for new, higher luminosity interaction regions
  - large aperture, high gradient quadrupoles from Nb_3Sn
  - high field beam separation dipoles and strong correctors
- Developing advanced beam diagnostics and instrumentation
- Commissioning of hardware for the LHC, especially US deliverables

Fermilab roles in LARP



- *plus ~50 other participants*
- *for most, very part-time*

Fermilab Contributions to LARP Tasks

- Magnet Systems -- many; geared toward upgrades

- Accelerator Systems
  - Instrumentation
    - beam oscillation frequency monitoring devices
    - beam optics diagnostics device (AC dipole)
  - Accelerator Physics
    - beam-beam interactions -- calculations and compensation
    - IR upgrade optics
  - Collimation
    - understand/improve 3-stage system for protecting IR's
  - Commissioning -- IR, other Hardware, Beam

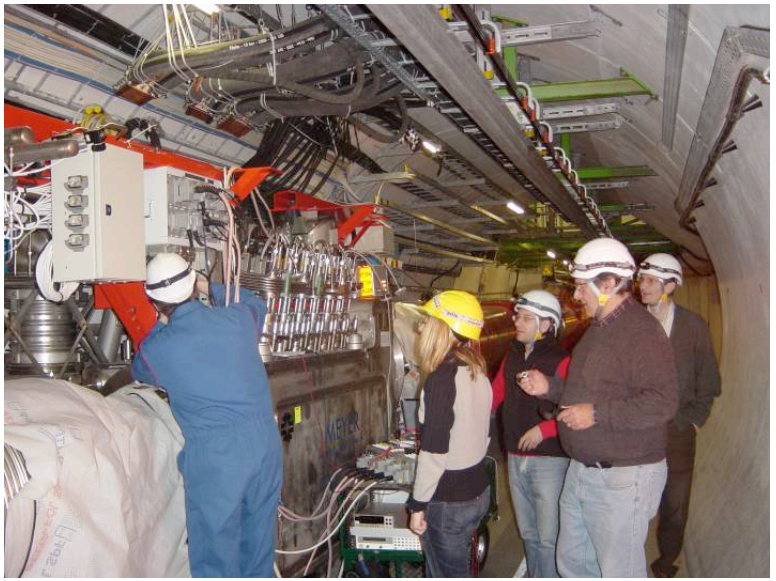
Commissioning of LHC Hardware

- DOE has responsibility to commission delivered hardware from the US LHC Accelerator Project -- handled through LARP
- As CERN further developed its commissioning strategy, in 2004 realized a shortage of personnel for commissioning hardware in the tunnel
  - ~43 key personnel short of needs
  - sought help across Europe, world
  - DOE responded
    - Commissioning Task Force formed thru LARP
  - new "task" formed within LARP organization:
    - Hardware Commissioning -- long-term visitors

IR/HW Commissioners via LARP

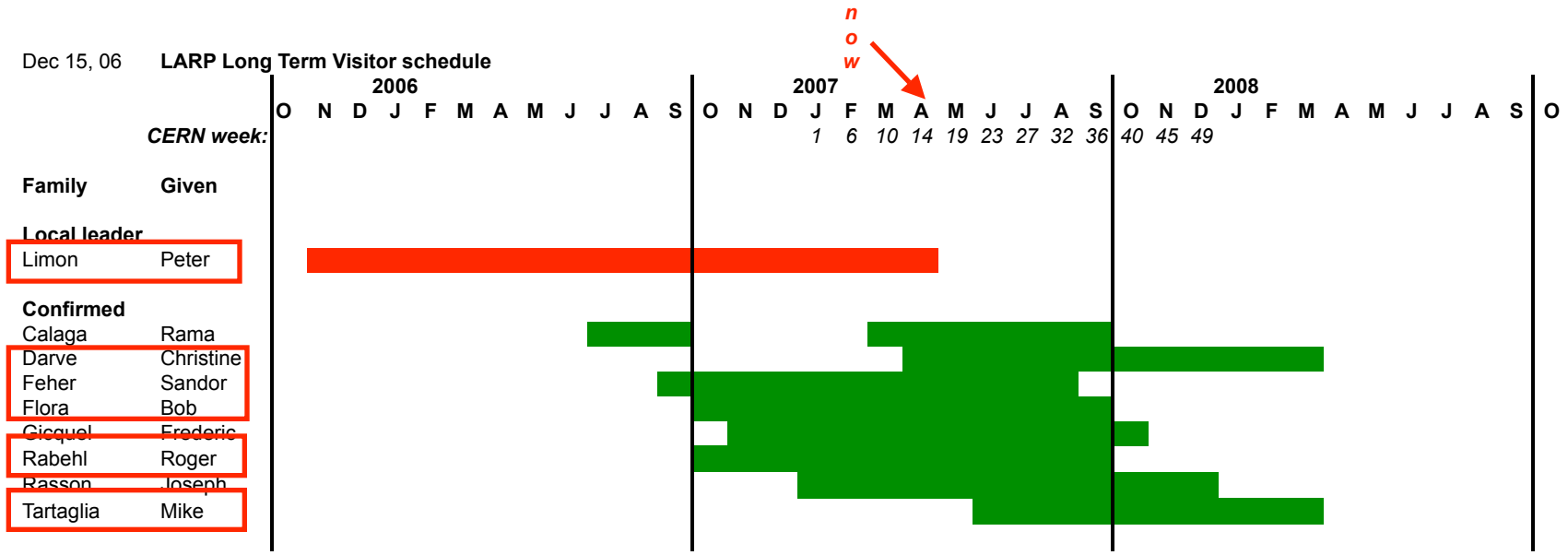
Installation Oversight

- First USLHC String (Q1-Q3/Feedbox/D1) transported to tunnel in Nov/Dec 2005
- LARP Oversight and technology transfer for USLHC interconnects
- 7 LARP personnel from three institutions during January/Feb 2006
- Peter Limon, Fermilab, first to CERN
  - Liaison with LARP, Safety Officer
  - Installation oversight
  - Assisting in Vacuum issues for Special Short Straight Sections (SSSS)
- 3 more now from Fermilab (long-term)



IR/HW Commissioners via LARP

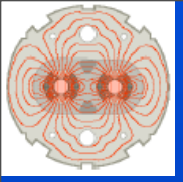
- IR commissioning has much overlap with general Hardware Commissioning
  - Fermilab commissioners are split 50/50 between these two tasks
  - cryo, power, magnet experts sent
  - personnel "integrated" into CERN departments, teams



Toward Beam Commissioning: LARP

- From start, commissioning part of LARP "mission"
  - original goal set by LARP: "1 US person per shift"
  - Santa Rosa meeting: CERN identifies best LARP role (see next slide)
- LARP deliverables -- participate in their commiss.
  - luminosity monitors, tune monitors, etc.
  - roles in development of other devices: ac dipole, collimators, etc.
- General beam commissioning:
  - CERN: must meet needs, etc.; not just "watching"
  - wish to send ...
    - a) "Sr" personnel, with expertise
    - b) "Jr" personnel, who can lead in future

LTC Dec 14th 05 : LHC commissioning organisation



from Roger Bailey

R.Bailey
.Lamont
O.Bruning
P.Collier

Machine Coordinator
Weekly responsibility
3 needed

??

G.Arduini
R.Assmann
M.Giovannozzi
S.Fartoukh
J.Uythoven
J.Wenninger
F.Zimmermann
A.Butterworth

Accelerator Systems
As required
Defined responsibilities

Commissioner
Scheduled shifts years 1,2
Pool of at least 7 needed

EIC
Scheduled shifts long term
7 needed

All Identified

Operator
Scheduled shifts long term
7 needed

All Identified

Accelerator system

Activity 1
Activity 2

Activity n

Toward BC: LARP

- As LARP encompasses several national laboratories and university groups, need oversight of process for choosing long-term visitors for beam commissioning
- LTV Advisory Committee formed (MJS=chair)
  - members from all labs and from CERN
  - meet regularly to determine program priorities and recommend long-term visitors to be sponsored by LARP
  - funded to send several FTE's each year
- Additionally, Toohig Fellowships through LARP
  - 3-year post-doc fellowships awarded; 50% of time @ CERN
  - two awarded so far (BNL, LBNL)
  - http://www.interactions.org/toohig/

Toward BC: LAFS

- Recognized early-on that software development for beam operation was important task, and typically last on list during commissioning efforts; a good place for Fermilab to "plug-in"
  - this realization helped push -- from "accelerator side" -- the need for a "remote" operation center (LHC@FNAL)
  - FNAL had much experience with Tevatron Collider operation in accelerator data analysis, etc.
- Once LHC@FNAL became a reality,
  - to make best use of facility, needed to understand intricacies of CERN control system, interfaces, etc.
  - LARP opted not to develop software tasks; Fermilab took initiative

LAFS efforts

- Role-based Access
  - authentication of LHC applications user
  - authorization from CERN for the user
  - has become fundamental to the LHC software application development
  - settings history for all LHC applications will be generated through RBA
- Sequencer
  - initiating software tasks "on event" in sequential order
    - ex: fill ring 1; measure emittances, etc.; fill ring 2; ...
  - strong intellectual input based on Tevatron experience

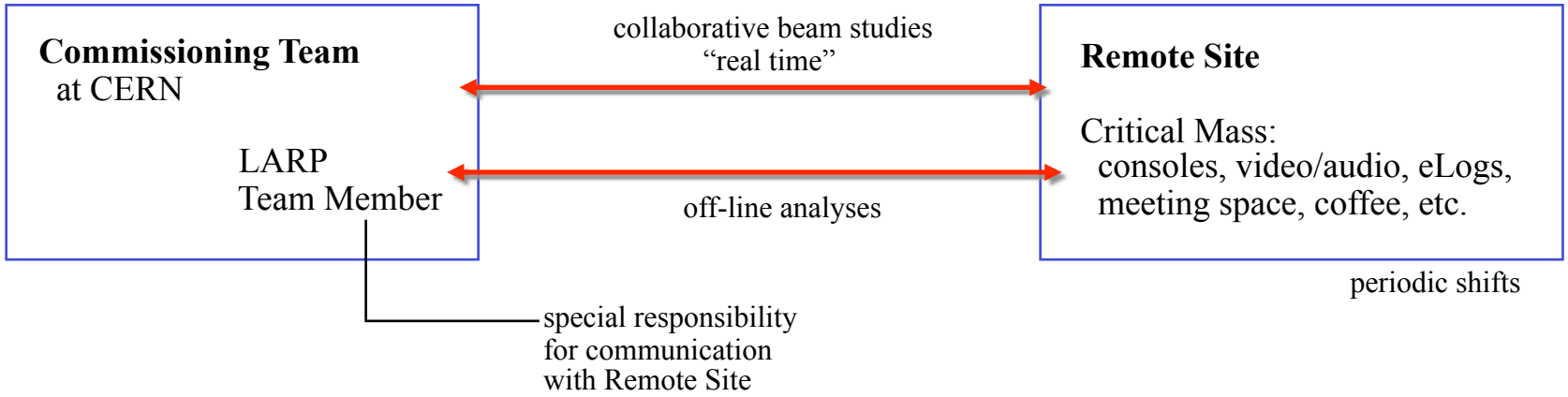
LAFS efforts

- Instrumentation Applications
  - tune display control room application
    - most mature coding at this point
  - wire scanner control room application
    - working on requirements and design documents
  - synchrotron light control room application
    - working on requirements and design documents
- Drag-and-drop Application Builder
  - just starting -- will make application generation easier
- LAFS effort is coordinated through CERN LHC Controls Department, with input from Operations Department
  - ~15 participants (~5-6 FTE) from Fermilab

Other Commissioning Experience for Future Needs

- Energy deposition and collimation
  - perhaps most pressing accelerator physics issue; FNAL has world-class expertise, well integrated into LHC
    - N. Mokhov and his Energy Deposition Group, D. Still, et al., of Tevatron Department, etc.
  - Stored energy in each LHC beam is ~250 times the stored energy in the Tevatron proton beam; luminosity upgrades will be even more concern
- IR upgrade design issues
  - though future task, will gain experience thru the present
  - magnet experts will be on-hand to learn about heat loads, quenches, etc. of the IR magnets in presence of beam

Types of Participation in Beam Commissioning



Four Types of Participation:

- Deliverables

  person builds something, visits to install, debug, etc., then leaves; may need remote access

- On-site Participation

  person has moved to CERN (for ~1 year, say) and works daily with LHC group

- 1-on-1 Contacts

  person works with a particular person or group located at CERN, with occasional trips to CERN to participate in a study, etc.

- Remote Participation

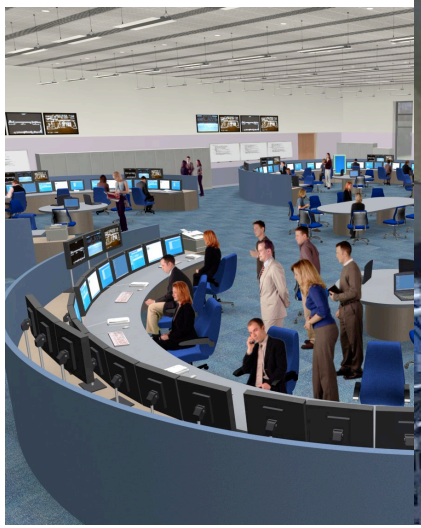
  person is part of a group at Remote Site, participating daily for shorter time periods

  "Training" can be performed at the Remote Site; periodic, shorter trips to CERN working with the "On-site" commissioners; people can continue to work remotely upon return

Toward BC: LHC@FNAL

- A remote operations center, modeled after the newly-built CERN Control Centre (CCC)
  - Driven by CMS, w/ much input from Accelerator Division
- Will serve as point of remote participation for both CMS detector and accelerator personnel

CCC- artist cpt.



CCC - as-built

LHC@FNAL

Toward BC: LHC@FNAL

- Adjacent, and connected to the 1E Conference Room, LHC@FNAL provides conduit to the CERN CCC and accelerator data, as well as CMS system
- Major challenge has been to make secure connections to CERN control system, without compromise of control/operation from CERN (especially for accelerator system). "Role-based access" has helped to ease this issue

LHC Beam Commissioning Time Line

- shorter-term
  - complete HW and IR commissioning
  - schottky monitors; ac dipoles
  - RBA software; sequencer input
  - 450 GeV initial tests -- several commissioners to be on-hand from Fermilab
- longer-term
  - start-up in '08
    - LARP will send several beam commissioners; list being negotiated with CERN at this time
    - through LHC@FNAL, will be able to monitor and help diagnose from Fermilab during commissioning
    - roles being established in collaboration with CERN/LARP

Summary -- 1

- Fermilab has been involved with CERN in LHC commissioning issues for several years now
- played(ing) major role in commissioning and troubleshooting of US deliverables
- provided(ing) engineering and other technical help during Hardware Commissioning period
- established strong ties to beam start-up/comm.:
  - role-based access and LHC@FNAL
  - sequencer; store data analysis
  - instrumentation/diagnostics; beam collimation/protection

Summary -- 2

- LHC@FNAL will play a role
  - training on Control system, CCC environment
  - pre-/post-visit involvement in commissioning activities, beam studies, accelerator data analysis
- Fermilab plays major role in national program (LARP)
  - ~50+ part-time participants from Fermilab
- have also established joint software initiative (LAFS) with CERN LHC/OPS to
  - enhance our abilities to engage -- remotely as well as at CERN -- in commissioning and beam studies
  - deliver desirable controls applications to ensure timely commissioning of the accelerator